TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Chaitra

Exam.	Regular (New Course)		
Level	BE	**Full Marks**	60
Programme	BEL	**Pass Marks**	24
Year / Part	III / I	**Time**	3 hrs.

Subject: - Engineering Thermodynamics and Heat Transfer *(ENME 310)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) Differentiate between state and path function with examples. [3]
   b) Write down salient characteristics of stored energy. Also, define total energy of a system. [3]
2. a) Define the term quality and write its relationship with moisture content. Derive the expression for specific volume of a two-phase mixture in terms of quality. [3]
   b) Write the functions and governing equation for an adiabatic nozzle and an evaporator. [3]
3. a) State Clausius and Kelvin-Plank statement of second law of thermodynamics and show their equivalence. [3]
   b) Derive the efficiency of an ideal gas power cycle in terms of pressure ratio with corresponding processes on P-V and T-S diagrams. Explain the effects of regeneration on the cycle. [5]
4. a) List the four fundamental thermodynamic processes of an ideal vapour compression refrigeration cycle and show them in a P - h diagram. Also draw a layout of steam power plant with its essential components. [5]
   b) Define the terms fin performance and fin effectiveness. Also derive an expression for critical radius of insulation for cylinders. [5]
5. At the inlet and outlet of turbine the absolute steam pressures are 6,000 kPa and 4.0 cm of Hg respectively. Barometric pressure is 75 cm of Hg. Calculate the gauge pressure for the entering steam and vacuum gauge pressure for the exiting steam. [5]
   [Take $\rho Hg = 13600\ kg/m^3$ and $g = 9.81\ m/s^2$].
6. A rigid vessel having a volume of $0.02\ m^3$, initially contains water at its critical state. The vessel is cooled until its pressure drops to 2000 kPa Determine: [5]
   a) The mass of water present in the vessel,
   b) The quality at final state, and
   c) The mass of saturated liquid water and saturated water vapour at the final state.
7. Air at 100 kPa and 127°C enters an adiabatic diffuser at a rate of 1.5 kg/s and leaves at a pressure of 150 kPa. The velocity of the air is decreased from 250 m/s to 50 m/s as it passes through the diffuser. Determine the exit temperature of the air and the exit area of the diffuser. [For air, take R = 287 J/kgK, $c_P = 1005$ J/kgK]. [5]
8. Steam enters into a turbine at 2 MPa, 400 °C and with a velocity of 200 m/s and saturated vapour exits from the turbine at 100 kPa with a velocity of 80 m/s. The power output of the turbine is 800 kW when the mass flow rate of steam is 1.5 kg/s. Turbine rejects heat to the surroundings at 300 K. Determine the rate at which the entropy is generated within the turbine. [5]
9. An air-standard Diesel cycle has a compression ratio of 18, and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process the pressure is 0.1 MPa and the temperature is 15°C. Determine: (a) the thermal efficiency, and (b) the mean effective pressure. [Take $\gamma = 1.4$, and $c_P = 1005$ kJ/kgK] [5]

10. A hot room wall has made of 40 cm of brick on the outside, 12 cm of plastic foam and finally 2 cm of fire clay on the inside. The inside and outside temperatures are 570°C and 210°C respectively. If inside and outside heat transfer coefficients are 56 W/m^2K and 6 W/m^2K and thermal conductivities of brick, foam and fire clay are 0.98 W/mK, 0.02 W/mK and 0.09 W/mK respectively, Determine: [5]
    a) Rate of heat loss from the hot room if the total wall area is100 m^2 and
    b) The temperature of outer surface of the brick.

***

Table of Saturated water Pressure Table

P kPa	T °C	v_l m^3/kg	v_{lg} m^3/kg	v_g m^3/kg	h_l KJ/kg	h_{lg} KJ/kg	h_g KJ/kg	s_l KJ/kg.K	s_{lg} KJ/kg.K	s_g KJ/kg.K
10	45.817	0.001010	14.673	14.674	191.83	2392.0	2583.8	0.6493	7.4989	8.1482
100	99.632	0.001043	1.6933	1.6943	417.51	2257.6	2675.1	1.3027	6.0562	7.3589
500	151.87	0.001093	0.3738	0.3749	640.38	2108.2	2748.6	1.8610	4.9604	6.8214
2000	212.42	0.001177	0.09841	0.09959	908.69	1890.0	2798.7	2.4471	3.8925	6.3396
4000	250.39	0.001252	0.04852	0.04977	1087.2	1713.4	2800.6	2.7962	3.2727	6.0689
22055	373.98	0.00311	-	0.00311	2086	-	2086	4409	-	4409

Table of Superheated Vapour

P kPa	T °C	v m^3/kg	u KJ/kg	h KJ/kg	s KJ/kg
100	99.63	1.6943	25.5.7	2675.1	7.3589
	150	1.9364	2582.4	2776.1	7.6129
	250	2.4061	2733.3	2973.9	8.0325
	300	2.6388	2810.1	3073.9	8.2152
	400	3.1027	2967.7	3278	8.5432
	450	3.3342	3048.9	3382.3	8.6927
	500	3.5655	3131.6	3488.2	8.8342

P kPa	T °C	v m^3/kg	u KJ/kg	h KJ/kg	s KJ/kg
1000	179.92	0.1944	2583.3	2781.2	6.5529
	200	0.2059	2621.5	2827.4	6.6932
	250	0.2326	2709.2	2941.9	6.9235
	300	0.2579	2792.7	3050.6	7.1219
	400	0.3066	2957.2	3263.8	7.4648
	450	0.3304	3040.3	3370.7	7.618
	500	0.3541	3124.5	3478.6	7.7622

P kPa	T °C	v m^3/kg	u KJ/kg	h KJ/kg	s KJ/kg
2000	212.42	0.09959	2599.5	2798.7	6.3396
	250	0.1114	2678.8	2901.6	6.5438
	300	0.1254	2771.8	3022.7	6.7651
	400	0.1512	2945.1	3247.5	7.1269
	450	0.1635	3030.5	3357.5	7.2845
	500	0.1757	3116.3	3467.7	7.4318

P kPa	T °C	v m^3/kg	u KJ/kg	h KJ/kg	s KJ/kg
4000	250.39	0.04977	2601.5	2800.6	6.0689
	300	0.05882	2724.4	2959.7	6.3598
	400	0.0734	2919.8	3213.4	6.7688
	450	0.08002	3010.3	3330.4	6.9364
	500	0.08642	3099.7	3445.4	7.0902